became oxygen dependent. The need for supplemental oxygen was not specifically reported in our series; however, the CTCAE defines grade 2 hypoxia as the need for intermittent oxygen and grade 3 as the need for continuous oxygen. Seven patients became oxygen dependent after treatment (at 30 days); however, by 3 months none of these patients were dependent on oxygen.

More recently, the Radiation Therapy and Oncology group[17] completed a phase II study of SBRT in high-risk patients. Grade 3 and 4 protocol-specific toxicities were reported in 7 of 55 patients (12.7%) and 2 of 55 (3.6%), respectively. All but 1 of these (8/55, 14.5%) of these toxicities were respiratory associated. In our series, 21 of 148 patients (14.2%) had perioperative grade 3 or 4 respiratory complications, suggesting that even in a compromised patient population resection can be undertaken with similar outcomes to SBRT. Currently, the American College of Surgeons and the Radiation Therapy and Oncology Group are developing a randomized study to compare SR and SBRT in high-risk patients with lung cancer. Treatment-related toxicity and effects on pulmonary function will be key end points in this study.

In conclusion, in this randomized study of a patient cohort with stage I NSCLC at greater than average risk for lobectomy, brachytherapy had no significant effect on lung function at short-term follow-up. FEV1% and DLCO% were equally preserved in both groups. The 30-day incidences of grade 3 and 4 respiratory complications in the SR and SRB arms were not significantly different. Follow-up, including recording of pulmonary function, is ongoing at the 12- and 24- month time points to ascertain the long-term impact of brachytherapy on lung function.

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Discussion

Dr Walter Weder *(Zurich, Switzerland).* Fernando and colleagues are to be congratulated for having initiated and now finished a prospective, multicenter, randomized trial evaluating an important oncologic question. Today they report on a secondary study end point, lung function and dyspnea. Dr Fernando, congratulations on your clear presentation and thanks for sending me the manuscript long before the meeting. I have 3 questions. In your article, you discussed the Lung Cancer Study Group Trial, which evaluated lobectomy versus sublobar resection and you commented as follows about pulmonary function tests, "However, values were only obtained for 60% of eligible patients who had at least 9-month follow-up." My comment on your study is the same. Unfortunately, for only two thirds of the patients were the pulmonary function test values available at 3 months, and for less than half at 12 months. Why didn't you wait a few more months with your analysis and publication? This would have improved the value of this report significantly.

I will continue with my second question. The patients you included had either low forced expiratory volume in 1 second or low diffusing capacity of the lung for carbon monoxide. I assume this is typically the patient with emphysema. You also included, however, patients with either high pulmonary artery pressure or impaired left ventricular function, and the pulmonary function test values in these patients were normal. So these are completely different disease categories. My question is, why didn't you

analyze these 2 groups of patients separately? I assume that any effect of brachytherapy on lung function could vary by disease category. Finally, in your manuscript you mentioned that endobrachytherapy delivers 100 Gy. What is the depth of the radiation field of this locally applied radiation therapy?

Dr Fernando. Thank you very much. Those are great questions, and I appreciate the challenge. I think that you picked up a major point. We only have the 3-month data in detail. We debated how much we should put into the discussion of 12-month data that we had available. We decided that we could report what we have at the moment, but as we get the longer and more complete follow-up, we recognize that 12-month data results may change. Analyzing the 12-month data is important, because radiation pneumonitis can be seen up to 6 months afterward. Currently, we don't see a difference at 12 months; however, that may change, and that will be reported in detail when available.

In terms of analyzing the groups you mention separately, that's a good question. We didn't—

Dr Weder. Can I interrupt briefly? So what, then, is the value of the current analysis? You said that the major impact of radiation pneumonitis is at 3 to 6 months. If you are not waiting that time, we get the report that tells us, ''Yes, it may not have an impact, but we are not really sure.'' If you would have waited another 6 months, we would have the relevant information.

Dr Fernando. Well, the 12-month data would help answer the question specifically about radiation pneumonitis, but not about other pulmonary complications, which typically you can see in the perioperative period up to 30 days. So I think that the 30-day information is still important. In previous studies, radiation pneumonitis has not really been reported with brachytherapy, although that is one of the things about which people remain concerned. We are taking a patient population at greater than average risk, we're suturing on the lung, we're not using Peri-Strips, for instance, to buttress the repair. Other surgeons are concerned about the risk of things like prolonged air leaks, pneumonia, and even empyemas. We didn't see any empyemas in this group. So I think the longer follow-up will really address the issue of radiation pneumonitis in its own right, and hopefully we can answer that question better then.

In terms of the second question, why we didn't analyze the groups separately, the data that we have on the data sheets that the various site clinical research associates sent to us did not specifically separate out those groups. I think that's a very interesting question. We do have access to the source documents (the pulmonary function test values), and so perhaps we will have to go back and analyze that information, so that we can try and separate those patients into those who maybe have more restrictive disease rather than emphysema. I think that's an excellent question, and something that we should address.

Can you remind me of the third question?

Dr Weder. You mention in the manuscript that a 100-Gy dose is delivered but say nothing about the depth of the radiation. Is it a few millimeters, or more?

Dr Fernando. It's about 5 to 7 mm or up to 1 cm, depending on how strong those radiation seeds are. So, in effect, what we're doing is improving our margins. I'm not sure which patients this benefits, but I suspect that the patients who will benefit are those patients who have close wedge resections or close margin wedge resections. If you do a wedge resection with a 1-cm margin or a margin at least the diameter of the tumor, or you do a good segmental resection, probably the brachytherapy will not be as helpful.

Dr Weder. Thank you.

Dr Scott J. Swanson *(Boston, Mass).* Excellent paper. I thought it was really useful to hear that information at this point. Did your teams learn anything about how to put these seeds in, such that it got easier over the course of the trial? Can you share any of that technical information? Second, pertaining to that last point, can you share any information about margins? Did you measure margins? Do you have any data about margins?

Dr Fernando. I'll take the margin question first. I've gone through the reviews that I've done thus far. One of the secondary end points we had was to look at staple-line cytology. There are some Japanese data, I think by Sawabata, where he swiped the specimen on a glass slide and found differences between the staple-line cytology and the actual histology. He even identified patients who had positive staple-line cytology yet negative histology. So we put that in as a secondary end point that we're measuring, and those data will eventually be presented. But what's interesting, as I read through the reports, is that people are actually getting reads from their cytologists in there and they are going back and taking bigger and bigger margins. So I think as a group, the surgeons are actually doing better wedge resections or better segments than maybe in previous studies. So far I have not seen lot of local recurrences in the cases that I've analyzed.

The second thing, in terms of what have I learned, in terms of a thoracoscopic approach, I personally like to use the Endo-Stitch a lot, and I found with some of the Vicryl meshes that we have that the Endo-Stitch does not sew very well through the mesh, and the needle tends to get stuck. It's a blunter needle. So I changed to using a standard needle, and what I do is I place the stitch through the mesh and then into the lung, bring it up, and I have 2 long strands of suture. Rather than trying to do an endoscopic tie, what I do is I simply put a series of clips along the suture. So the clips serve as my tie on the suture, and that also avoids having to actually do an intracorporeal knot in the patient.

Dr Nasser K. Altorki *(New York, NY).* I enjoyed your presentation. I want to agree a little bit with you and a little bit with Walter. He made his point, but I think that there is a real issue of delivering 100 Gy to a fresh suture line, and I think all of us who do this worry about the issues that you described. I think in that sense your report is helpful. Can you share with us issues that relate to radiation exposure in the operating room? What do you do? What is the risk to people in the room? You sew it. Do you wear radioprotective gloves? Do you wear a shield?

Dr Robert J. Cerfolio *(Birmingham, Ala).* And any surgical team members who might be pregnant in the operating room, which is an issue.

Dr Fernando. That issue of radiation safety has been reported in another article, with data not from this study but from a previous single-center study (Smith RP, Schuchert M, Komanduri K, Burton S, Heron DE, Luketich JD, et al. Dosimetric evaluation of radiation exposure during I-125 vicryl mesh implants: implications for ACOSOG z4032. *Ann Surg Oncol*. 2007;14:3610-3). You have to follow the regulations in place in your own hospital and within your own state. I wear a lead apron when I do this. I try not to handle the seeds directly, for instance not tying right down into the knot with my fingers. When the implant is prepared,

what you do is basically to place all the sutures in place into the mesh with a lead shield over the active radiation seeds, and then when you're ready, you have all 4 sutures with the seeds into the mesh. You pull each suture through, so that you are minimizing radiation exposure. The radiation physicist is in the room measuring the radiation in the room and around the room. In terms of actual safety for the patient, it's really very safe. It's a low dose rate brachytherapy. And the falloff is rapid as you move away from the source. In the study I just mentioned, dosimeters placed on the patient's shoulder measured very low doses of radiation in these patients who had an implant placed. So it's actually a low dose of radiation exposure.

Dr Altorki. There is a glove that is lead impregnated that you could use.

Dr Daniel L. Miller *(Atlanta, Ga).* With regard to placement, what we at Emory and some other surgeons throughout the United States have been using is the pericardial Veritas strip, which is a little bit wider. They have a wider version, and it's very easy to handle. You bring the suture out, and you clip the radiation seed suture onto the buttress material. So you have no extra holes into the lung. When you have expansion of the lung, there's no tearing and so forth. It really minimizes the amount of time spent handling the radiation, and you're not suturing into the lung in a way that may produce prolonged air leaks and so forth. I know that wasn't allowed in this portion of the study, it's off-study; however, I think that in the future this is another way to look at that, to minimize other lung problems and so forth.

Dr Fernando. Thank you.